Assessment of listing and categorisation of animal diseases within the framework of the Animal Health Law (Regulation (EU) No 2016/429): infestation with Varroa spp. (varroosis)

Thulke, Hans-Hermann

2017-10-06

Thulke , H-H & Panel on Animal Health and Welfare (AHAW 2017 , ' Assessment of listing and categorisation of animal diseases within the framework of the Animal Health Law (Regulation (EU) No 2016/429): infestation with Varroa spp. (varroosis) ' , EFSA Journal , vol. 15 , no. 10 , 4997 . https://doi.org/10.2903/j.efsa.2017.4997

http://hdl.handle.net/10138/231169
https://doi.org/10.2903/j.efsa.2017.4997

SCIENTIFIC OPINION

EFSA Journal

ADOPTED: 14 September 2017

doi: 10.2903/j.efsa.2017.4997

Assessment of listing and categorisation of animal diseases within the framework of the Animal Health Law (Regulation (EU) No 2016/429): infestation with *Varroa* spp. (varroosis)

EFSA Panel on Animal Health and Welfare (AHAW),
Simon More, Anette Bøtner, Andrew Butterworth, Paolo Calistri, Klaus Depner, Sandra Edwards, Bruno Garin-Bastuji, Margaret Good, Christian Gortázar Schmidt, Virginie Michel, Miguel Angel Miranda, Søren Saxmose Nielsen, Mohan Raj, Liisa Sihvonen, Hans Spoolder, Jan Arend Stegeman, Hans-Hermann Thulke, Antonio Velarde, Preben Willeberg, Christoph Winckler, Francesca Baldinelli, Alessandro Broglia, Denise Candiani, Frank Verdonck, Beatriz Beltrán-Beck, Lisa Kohnle and Dominique Bicout

Abstract

Infestation with *Varroa* spp. (varroosis) has been assessed according to the criteria of the Animal Health Law (AHL), in particular criteria of Article 7 on disease profile and impacts, Article 5 on the eligibility of varroosis to be listed, Article 9 for the categorisation of varroosis according to disease prevention and control rules as in Annex IV and Article 8 on the list of animal species related to varroosis. The assessment has been performed following a methodology composed of information collection and compilation, expert judgement on each criterion at individual and, if no consensus was reached before, also at collective level. The output is composed of the categorical answer, and for the questions where no consensus was reached, the different supporting views are reported. Details on the methodology used for this assessment are explained in a separate opinion. According to the assessment performed, it is inconclusive whether varroosis can be considered eligible to be listed for Union intervention as laid down in Article 5(3) of the AHL because there was no full consensus on the criterion 5 A(v). Consequently, the assessment on compliance of varroosis with the criteria as in Annex IV to the AHL, for the application of the disease prevention and control rules referred to in Article 9(1), and which animal species can be considered to be listed for varroosis according to Article 8(3) are also inconclusive.

Keywords: Varroosis, *Varroa* spp., *Varroa destructor*, Animal Health Law, listing, categorisation, impact

Requestor: European Commission

Question number: EFSA-Q-2017-00151

Correspondence: alpha@efsa.europa.eu

Panel members: Dominique Bicout, Anette Bøtner, Andrew Butterworth, Paolo Calistri, Klaus Depner, Sandra Edwards, Bruno Garin-Bastuji, Margaret Good, Christian Gortázar Schmidt, Virginie Michel, Miguel Angel Miranda, Simon More, Søren Saxmose Nielsen, Mohan Raj, Liisa Sihvonen, Hans Spoolder, Jan Arend Stegeman, Hans-Hermann Thulke, Antonio Velarde, Preben Willeberg and Christoph Winckler.

Acknowledgements: The Panel wishes to thank Marie-Pierre Chauzat and Peter Rosenkranz for the support provided to this scientific output.

Suggested citation: EFSA AHAW Panel (EFSA Panel on Animal Health and Welfare), More S, Bøtner A, Butterworth A, Calistri P, Depner K, Edwards S, Garin-Bastuji B, Good M, Gortázar Schmidt C, Michel V, Miranda MA, Nielsen SS, Raj M, Sihvonen L, Spoolder H, Stegeman JA, Thulke H-H, Velarde A, Willeberg P, Winckler C, Baldinelli F, Broglia A, Candiani D, Verdonck F, Beltrán-Beck B, Kohnle L and Bicout D, 2017. Scientific opinion on the assessment of listing and categorisation of animal diseases within the framework of the Animal Health Law (Regulation (EU) No 2016/429): infestation with *Varroa* spp. (varroosis). EFSA Journal 2017;15(10):4997, 25 pp. https://doi.org/10.2903/j.efsa.2017.4997

ISSN: 1831-4732

The EFSA Journal is a publication of the European Food Safety Authority, an agency of the European Union.

Table of contents

1. Introduction

1.1. Background and Terms of Reference as provided by the requestor

The background and Terms of Reference (ToR) as provided by the European Commission for the present document are reported in Section 1.2 of the scientific opinion on the ad hoc methodology followed for the assessment of the disease to be listed and categorised according to the criteria of Article 5, Annex IV according to Article 9, and 8 within the Animal Health Law (AHL) framework (EFSA AHAW Panel, 2017).

1.2. Interpretation of the Terms of Reference

The interpretation of the ToR is as in Section 1.2 of the scientific opinion on the ad hoc methodology followed for the assessment of the disease to be listed and categorised according to the criteria of Article 5, Annex IV according to Article 9, and 8 within the AHL framework (EFSA AHAW Panel, 2017).

The present document reports the results of assessment on infestation with *Varroa* spp. (varroosis) according to the criteria of the AHL articles as follows:

- Article 7: varroosis profile and impacts
- Article 5: eligibility of varroosis to be listed
- Article 9: categorisation of varroosis according to disease prevention and control rules as in Annex IV
- Article 8: list of animal species related to varroosis.

2. Data and methodologies

The methodology applied in this opinion is described in detail in a dedicated document about the ad hoc method developed for assessing any animal disease for the listing and categorisation of diseases within the AHL framework (EFSA AHAW Panel, 2017).

3. Assessment

3.1. Assessment according to Article 7 criteria

This section presents the assessment of infestation with *Varroa* spp. (varroosis) according to the Article 7 criteria of the AHL and related parameters (see Table 2 of the opinion on methodology (EFSA AHAW Panel, 2017)), based on the information contained in the fact-sheet as drafted by the selected disease scientist (see Section 2.1 of the scientific opinion on the ad hoc methodology) and amended by the AHAW Panel.

3.1.1. Article 7(a) Disease Profile

There are four species in the genus *Varroa* (Parasitiformes; Varroidae): *V. destructor*, *V. jacobsoni*, *V. underwoodi* and *V. rinderer*i. The disease known as Varroosis is caused by *Varroa destructor*,[1] which is an ectoparasitic honey bee mite that has successfully shifted from the original host, *Apis cerana*, to the Western honey bee, *Apis mellifera*, which the present document mainly refers to. It is not surprising that the new host lacks features of a stable and relatively harmless host–parasite relationship as in *Apis cerana* which has developed during a long period of coevolution. The reasons for the host shift are unclear. Most likely this shift occurred when *A. mellifera* colonies were transported to eastern Russia or the Far East in the first half of the past century which led to a sympatric distribution of both honey bee species and might have allowed the parasite to infest the new host. Mites of Korean haplotype parasitise *A. mellifera* worldwide, including Europe. At least six other haplotypes have been described. *V. destructor* is closely linked to its honey bee host and lacks a free-living stage. There are two distinct phases in the life cycle of *V. destructor* females: a phoretic phase on adult bees and a reproductive phase within the sealed drone and worker brood cells (Figure 1). Males and nymph stages of the mite are short lived and can only be found within the sealed brood cells. On the adult bees, the *Varroa* females are transported to brood cells for their reproduction or spread by foraging and swarming bees. On the adult bees, the *Varroa* female usually is hidden under the sternites of the

[1] *V. destructor* species was proposed recently (Anderson and Trueman, 2000), before it was known as *V. jacobsoni*.

bee. The mites suck substantial amounts of haemolymph from both the adult bees and from the pre-imaginal host stages within the sealed brood cells (Rosenkranz et al., 2010).

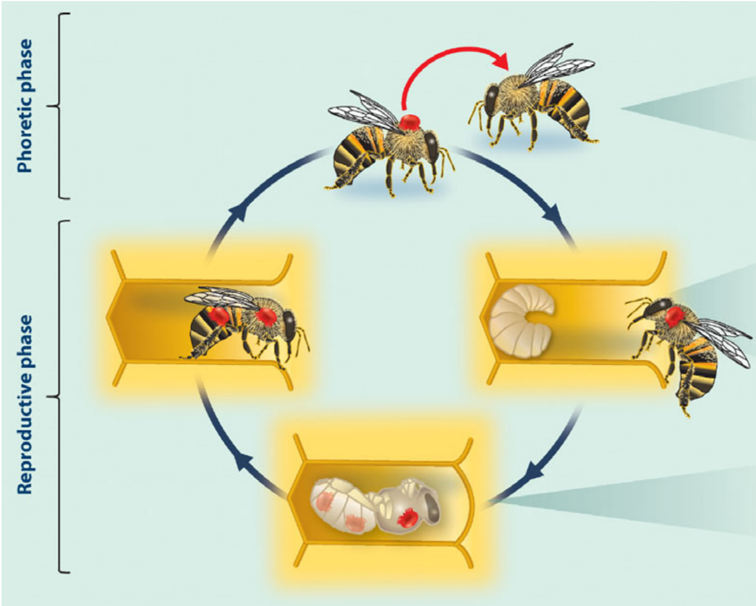

Figure 1: Life cycle of *V. destructor* in a honeybee colony; Annual Review of Entomology® (Nazzi and Le Conte, 2016)

3.1.1.1. Article 7(a)(i) Animal species concerned by the disease

Susceptible animal species

Parameter 1 – Naturally susceptible wildlife species (or family/orders)

To date in Europe, there have been no reported naturally susceptible wildlife species to *V. destructor*. Bumble bees and solitary bees have been the subject of many studies assessing parasitic and infectious agents in the wild. None have reported the presence of *V. destructor* (OIE, 2008).

In Asia, some bee species (genus *Apis*) are susceptible to the mite (Rosenkranz et al., 2010).

Parameter 2 – Naturally susceptible domestic species (or family/orders)

In Europe, *A. mellifera* is the only susceptible domestic species (Table 1). *A. cerana*, the Asiatic honey bee, a domestic bee not present in Europe, is also susceptible to *Varroa*, although, being coevolved with the parasite, it appears to have some defence mechanisms that control the mite infestation.

Table 1: Domestic species naturally susceptible to *V. destructor* in Europe

Species	Family	Order
Apis mellifera	Apidae	Hymenoptera

Parameter 3 – Experimentally susceptible wildlife species (or family/orders)

To date, no wildlife species have been experimentally shown to be susceptible to *V. destructor*.

Parameter 4 – Experimentally susceptible domestic species (or family/orders)

To date, no domestic species (apart from *A. mellifera* and *A. cerana*) have been experimentally shown to be susceptible to *V. destructor*.

Reservoir animal species

Parameter 5 – Wild reservoir species (or family/orders)

In Europe, there is no wild reservoir species. In Asia, wild bees are considered a reservoir for *V. destructor* (Rosenkranz et al., 2010; Roberts et al., 2015).

Parameter 6 – Domestic reservoir species (or family/orders)

In Europe, *A. mellifera* is the only reservoir of *V. destructor*. In Asia, other *Apis* species (e.g. *A. cerana*, *Apis nigrocincta*) act as reservoir for *Varroa* spp.

3.1.1.2. Article 7(a)(ii) The morbidity and mortality rates of the disease in animal populations

Morbidity

Parameter 1 – Prevalence/Incidence

Mite presence in colonies

If the colonies are not located in free zones, the prevalence of mites in honeybee colonies is virtually 100% as all colonies host mites. There might be temporary mite-free colonies as a consequence of intensive or 'overdosed' treatment activities.

Given the high rate of prevalence, it is difficult to calculate any rates of incidence. An experiment has been run in Germany to assess the re-infestation rates in specific conditions. It has shown that all colonies of this experiment have been continuously infested with *Varroa* mites throughout the whole period of the experiment despite continuous treatments in one of the modalities (Frey and Rosenkranz, 2014).

Parameter 2 – Case-morbidity rate (% clinically diseased animals out of infected ones)

The difficulty with varroosis is to establish thresholds for clinical signs. Honey bees are a so-called superorganism where clinical symptoms in some individuals can be buffered at the colony level to a certain point by the huge amount of still healthy bees and brood.

The ectoparasite mite *V. destructor* impairs both brood and adult bees causing a non-uniform disease pattern called varroosis or parasitic mite syndrome and including a specific form of brood damage termed 'snotty brood'. The symptoms of varroosis are dependent on the rate of mite infestation of a given colony and on viral infections vectored to individual bees by the parasitising mites. Infested colonies in temperate climates will eventually die within around 2 years after the initial infestation if left untreated. Varroosis inflicts much greater damage and higher economic costs than all other known bee diseases (Genersch et al., 2010).

Very few surveys have documented the incidence of varroosis in European countries. The last updated figures were produced by the EPILOBEE programme. Clinical prevalence of varroosis in the apiaries were recorded during 2 years (2012–2014) in 17 Member States (MSs) of the European Union (EU) and ranged between 0% and 52.6% (Laurent et al., 2016).

Mortality

Parameter 3 – Case-fatality rate

It is very difficult to assess how many colonies die because of *V. destructor*. However, most of epidemiological programmes assessing honeybee colonies mortalities underline the predominant role of the mite in colony mortalities as it was stated in Germany (the average *Varroa* infestation level in percentage in surviving colonies (av. $\pm$ s.e.: 3.4 $\pm$ 0.1) as significantly lower than in lost colonies (av. $\pm$ s.e.: 15.1 $\pm$ 0.7) (Genersch et al., 2010; Laurent et al., 2016); in Europe (Jacques et al., 2016, 2017), in Argentina (where colonies with treatment failure had 4.9 times more risk of mortality when the percentage of *Varroa* infestation prior to treatment was more than 3% (Giacobino et al., 2014) or in the US (Traynor et al., 2016). In temperate climate, colony mortality mainly occurs in late autumn or during winter due to the damage of winter bees in highly infested colonies.

The bees' behaviour can modulate the severity of infestation by the so called sensitive hygiene behaviour, which involves the detection and removal of brood parasitised by *Varroa* (Mondet et al., 2015).

3.1.1.3. Article 7(a)(iii) The zoonotic character of the disease

Varroosis is not a zoonotic disease.

3.1.1.4. Article 7(a)(iv) The resistance to treatments, including antimicrobial resistance

Parameter 1 – Resistant strain to any treatment even at laboratory level

V. destructor is treated with acaricidal active ingredients that include pharmaceutical chemicals, essential oils or organic acids. The effect of the acaricides on *V. destructor* has been studied by means of different bioassays. Here, we report only the study of mite resistance towards acaricides. A prompt detection of resistant *Varroa* population is vital to reduce the impact on bee losses and to test the susceptibility of the *Varroa* mites to new varroacidal substances. Some bioassays have been used to describe in the laboratory the resistance of *Varroa* to pyrethroids (tau-fluvalinate, flumethrin and acrinatrine) of mite populations from Italy and more recently from Czech Republic but no figures are available, e.g. on the percentage of population showing resistance (Milani, 1995; Kamler et al., 2016). So far, no standard test system for a reliable and accurate quantification of mite resistance to acaricides is available (Dietemann et al., 2013). It should be said that 'soft' acaricides – organic acids and essential oils have low probability of eliciting resistance after repeated treatments because they are less specific, they are only used over short time periods, there are almost no residues for long-term effects within the colony (Rosenkranz et al., 2010). The mechanism of action of 'soft' acaricides is very different from synthetic acaricides, which target specific physiological (detoxifying enzymes) processes that are highly regulated genetically.

In the field, resistance to amitraz, fluvalinate and coumaphos was also shown in Italy and the US (Milani, 1999). Strains of *Varroa* mites resistant to one pyrethroid usually show cross-resistance with other pyrethroids (Milani, 1999). Because several types of wax residues also may have some effect on mites in the sealed cells, they are likely to create acaricide resistance, thus causing unrecognised failure of control in the field and serious damage to beekeeping (Rosenkranz et al., 2010).

In conclusion, given that acaricide treatments are applied worldwide to control *Varroa* mites, resistances have appeared in different place of the world to different active ingredients. However, when the active ingredient is not used for a while (only 1 year of alternative treatment is effective), the frequency of the alleles for resistance declines rapidly (González-Cabrera et al., 2013). This characteristic is used in the management of acaricide resistance by rotating acaricides with different active ingredients and ways of effect.

3.1.1.5. Article 7(a)(v) The persistence of the disease in an animal population or the environment

Animal population

Given the nearly 100% prevalence of the *Varroa* mite in bee colonies in Europe, it is virtually impossible to assess usual criteria of infectious diseases such as infectious period in the honeybee colony, latent infection period, and the presence and duration of the mites in healthy carriers. Most likely, all these characteristics might be very dependent on the environment, honeybee subspecies, local beekeeper practices and climate (Meixner et al., 2015). In temperate climate regions, there is usually a low *Varroa* infestation level in spring (if beekeepers have treated in autumn) and an increase in mite population with, simultaneously, an increasing (re)invasion pressure. There is no place and climate where *Varroa* disappears from the colonies and re-infects late in the season. Once *Varroa* is in the colony, it stays the whole life of the colony. In the majority of cases, beekeepers have to treat their colonies to avoid collapses due to varroosis. If beekeepers do not treat the honeybee colonies, the collapse is expected within 2 years (Fries et al., 2006; Boecking and Genersch, 2008; Rosenkranz et al., 2010).

Environment

Parameter 4 – Length of survival (dpi) of the agent and/or detection of DNA in selected matrices (soil, water, air) from the environment (scenarios: high and low T)

V. destructor is closely linked to its honey bee host and lacks a free-living stage. *V. destructor* cannot survive longer than a few hours without honeybee colonies as it is an obligatory parasite. It cannot survive in soil, water or the open environment.

3.1.1.6. Article 7(a)(vi) The routes and speed of transmission of the disease between animals, and, when relevant, between animals and humans

Routes of transmission

Parameter 1 – Types of routes of transmission from animal to animal (horizontal, vertical)

Adult female *Varroa* mites are transported horizontally from colony to colony via drifting by foraging worker bees, vagrant drones and by robbing bees[2] or even by moving infected frames that may act as mechanical vectors. Vertical transmission takes place by swarming. In the new colony, introduced *Varroa* mites at first stay phoretically on the adult bees. The proliferation of the parasite occurs in the capped brood cells of the honey bee. For this to occur, the female mite invades a cell just before capping, preferring drone brood over worker brood (Boecking and Genersch, 2008).

Also, beekeeping practices can interfere with *Varroa* transmission as beekeepers can pass *Varroa* from one colony to other relocating hives, frames or bees.[3]

Parameter 2 – Types of routes of transmission between animals and humans (direct, indirect, including food-borne)

There is no transmission of *Varroa* between honeybees and humans, since it is not a zoonotic parasite.

Speed of transmission

The speed of transmission from colony to colony or from apiary to apiary has not been studied in detail but very likely depends on the density of honey bee colonies and activities of beekeepers. For instance, in case of translocation of honeybee colonies to target a special honey flow, a free zone (from *Varroa*) can be contaminated by infested colonies at a distance of hundreds of kilometres. In Europe, given that very few areas free of *Varroa* exist, beekeepers often noticed the increase of *Varroa* population in their colonies when the apiaries are located in zones where transhumance is dense, and contaminated colonies are being brought by beekeepers. Once *V. destructor* has reached a country, it has proved impossible to eradicate the parasite. Therefore, studies on transmission are rather difficult to run. Even in the recent introduction of the mite in Hawaii, no epidemiological study has followed the dispersal of the mite (Martin et al., 2012). *V. destructor* is present in most areas of the EU with rare exceptions. These sites free of mites are islands and remote valleys which give them specific characteristics of small isolated places. If the mite is introduced in those places, the dissemination to the entire territory will be quick and probably undetectable in the early stages.

3.1.1.7. Article 7(a)(vii) The absence or presence and distribution of the disease in the Union, where the disease is not present in the Union, the risk of its introduction into the Union

Presence and distribution

Parameter 1 – Map where the disease is present in the EU

V. destructor is present in all MSs of the EU with the exception of some islands and some remote valleys (in Scotland for example). Officially only two islands are recognised free of *Varroa* mites: the Isle of Man and the Åland Island (Finland) (Commission Implementing Decision 2013/503/EU[4]).

Parameter 2 – Type of epidemiological occurrence (sporadic, epidemic, endemic) at MS level

V. destructor has been present in the western EU since the late 1970s (Rosenkranz et al., 2010) and was detected earlier in some Eastern countries (Bulgaria, 1967). The mite is now endemic.

---

[2] In regions with a high density of honey bee colonies, the population dynamics are influenced by a permanent exchange of mites when foragers or drones enter foreign colonies or by robbing. Through this so called 'reinfestation', some colonies will lose mites, and others will receive mites. It is interesting to note that the robbing bees will 'receive' the mites from the victim colonies, which often are already weakened through a high *Varroa* infestation, and that the effective 'robbing distance' is more than 1 km (Frey et al., 2011). This behaviour means that during periods with low nectar flow and, therefore, high robbing activities, strong colonies may significantly increase their mite population (Rosenkranz et al., 2010).

[3] Checking the presence of *Varroa* on a queen and its (maximum 20) attendants is possible before movement but it is practically very difficult to check for *Varroa* in a package of hundreds/thousands of bees.

[4] 2013/503/EU: Commission Implementing Decision of 11 October 2013 recognising parts of the Union as free from varroosis in bees and establishing additional guarantees required in intra-Union trade and imports for the protection of their varroosis-free status. OJ L 273, 15.10.2013, p. 38–40.

Risk of introduction

V. destructor is already present in Europe.

3.1.1.8. Article 7(a)(viii) The existence of diagnostic and disease control tools

Diagnostic tools

The OIE manual describes three methods to diagnose the presence of *Varroa* mites in colonies: examination of honeybee colony debris, honeybee adults and honeybee brood (OIE, 2008).

Debris are collected at the bottom of honeybee colonies and are visually inspected to detect *Varroa* (technically, molecular methods can be run on debris, but they are extremely expensive compared to visual examination, and the quantification (number of mites) is not as precise. Therefore, they are never performed on a routine basis). Colonies can be equipped with meshed floors and bottom boards are used to collect debris. In case of plain floors, dedicated panels can be inserted on the floor to collect debris (Ryba et al., 2012). The collection duration varies depending on the conditions. Collection of mites can be increased by the use of varroacides in the honeybee colonies. However, small or initial infestations of a colony might not be detected by these methods, which suggests that an infection level threshold must be exceeded before the detection of infection is possible.

Adults of honeybees (usually 300) can be sampled directly from the colony into a jar. To dislodge mites from the bees, icing sugar, washing liquid or alcohol can be used. Subsequently the mites are collected using a sieve. Various techniques are widely used and described in the literature (boxes, jars, funnels or roofs of colonies can be used to collect adult honeybees).

The examination of brood, whether it is drone (male) brood or worker (female) brood involves uncapping cells. Pupae removed from the cells are examined together with the cells and mite collected (EFSA AHAW Panel, 2016).

Diagnostic of varroosis

Varroosis is mainly triggered by the viral infections transmitted and activated by the parasitising mites. There is no clear consensus in the scientific community to describe the disease. Using the techniques briefly described above, various thresholds are provided in the literature to evaluate varroosis. They depend on years, geographical zones and history of colony treatments and should, according to recent publications, include prevalence and infection rates of honey bee viruses transmitted by the mite (Kang et al., 2015; Giacobino et al., 2016; Wilfert et al., 2016).

The final breakdown of a honey bee colony is associated with the typical 'parasitic mite syndrome' such as scattered brood, crawling or even crippled bees, supersedure of queens and unexplainable reduction of the bee population (Rosenkranz et al., 2010).

Control tools

Parameter 2 – Existence of control tools

National regulations can require treatment against varroosis as, e.g. in Germany, France and the UK. The products that are used are listed in Section 3.1.4.3 and their efficacy depends on many factors, for instance beekeeping practices, climate conditions (see details in Section 3.1.1.4). It is usually admitted that limiting the number of mites is the best way against *V. destructor* using control methods with acaricides or zootechnical methods (drone brood traps). Once the colony exhibits clinical signs (meaning that significant numbers of mites are present), it is unlikely that the colony can survive the winter. Without periodic treatment, most of the honey bee colonies in temperate climates would collapse within a two 3-year period (Rosenkranz et al., 2010). Therefore, *Varroa* control strategies have had to become an integral part of beekeeping practice to keep infestation levels below the damage threshold for reducing colony losses caused by this parasite.

3.1.2. Article 7(b) The impact of diseases

3.1.2.1. Article 7(b)(i) The impact of the disease on agricultural and aquaculture production and other parts of the economy

The level of presence of the disease in the Union

Parameter 1 – Number of MSs where the disease is present

The disease is present is all MSs with some rare local exceptions (see Section 3.1.1.7).

The loss of production due to the disease

Parameter 2 – Proportion of production losses (%) by epidemic/endemic situation

It is very difficult to assess the production losses due to either *Varroa* portage in colonies or ongoing varroosis although it is widely acknowledged that varroosis is one of the main honey disease reported worldwide (Chauzat et al., 2013; McMenamin and Genersch, 2015; Gisder and Genersch, 2017). The costs generated by *Varroa* presence in honeybee colonies have been estimated on honey production in some conditions, but it is impossible to generalise to all types of productions (biological beekeeping, beekeeping run in mountains, in forests, in field crops). In France, the cost of three *Varroa* mites per 100 bees has been estimated at a loss of 5 kg of honey on the lavender honey flow (Kretzchmar et al., 2016). Data were produced within the observatory for lavender honey flow set up in the south of France. The performance of 3,294 honeybee colonies was recorded between 2009 and 2016 in field conditions. The gain of weight was regularly measured from the moment where the beekeepers installed colonies in the field to the honey harvest. The gain of weight is an integrative variable that depends on the resources available for honeybees, the population of honeybees and the sanitary state of the colonies. *Varroa* mites were systematically counted on living honeybees when colonies were first installed for lavender honey flow. Results show that the gain of weight is around 23–24 kg for colonies that hosted between 0 and 3 mites per 100 bees. From the rate of 3 mites/100 bees, the gain of weight was systematically lower and negatively correlated with the number of mites: The gain was around 21.3 kg for colonies hosting 3–5 mites/100 bees, and around 18.14 kg for colonies hosting 5 mites to 8/100 bees. If not treated or badly treated, the honeybee colonies suffer from varroosis or die. In the latter case, the production of bee products is lost.

Indirect agricultural losses due to colony weakening because of *Varroa* could be also linked to the decrease in pollination service of honeybees in agricultural crops. The estimated value of insect pollination in agriculture, including honeybees, is globally EUR 153 billion a year, almost a tenth of the total value of world agricultural food production, and EUR 22 billion in Europe (European Commission, 2008), where the production of 84% of crop species cultivated depends directly on insect pollinators, especially bees (Gallai et al., 2009). The contribution of honeybees to pollination is estimated to vary considerably between different MSs, ranging from less than 25% (e.g. the UK, Finland) to more than 90% (e.g. Portugal, Ireland), depending on density of honeybees, temporal-spatial availability of hives in relation to pollination demand and other factors (Breeze et al., 2014).

3.1.2.2. Article 7(b)(ii) The impact of the disease on human health

This is not applicable because there is no transmission of *V. destructor* between animals and humans.

3.1.2.3. Article 7(b)(iii) The impact of the disease on animal welfare

In honeybees, the ability to express normal behaviour (e.g. feeding, orientation, communication, flight ability) and the health (e.g. decrease of normal weight, wing deformations), generally agreed as components of welfare, are compromised by *Varroa*, leading in certain cases to the total collapse of the colony. However, there is currently no specific definition of suffering in insects, and no means to measure suffering.

Parameter 1 – Severity of clinical signs at case level and related level and duration of impairment

All bee colonies in Europe (with rare exceptions, see above) host *Varroa* mites. When the parasitic mite syndrome is observed in a colony, the survival of the colony without treatment is at risk during the following winter. *Varroa* mites feed on larvae and adult bee haemolymph. They also transmit viruses that cause physiological and physical alterations, such as wing deformations. One mite decreases 7% of the weight of a single bee (De Jong et al., 1982) and between 11 and 19% in the case of drones (Duay et al., 2003), affecting flight ability (Duay et al., 2002). Also, parasitised foraging bees show less rates of returning to the colony and problems to get oriented (Kralj and Fuchs, 2006; Kralj et al., 2007).

3.1.2.4. Article 7(b)(iv) The impact of the disease on biodiversity and the environment

This is not applicable because there is no transmission of *V. destructor* to wild species in Europe.

The honey bee also provides pollination services to many wild plants, but the amount they contribute compared to wild pollinators might be lower than previously acknowledged and even pollination by managed honey bees supplements, rather than substitutes for, pollination by wild insects (Potts et al., 2010; Garibaldi et al., 2013). Therefore, plant biodiversity loss due to decline in pollination services by honeybees may not be significant.

3.1.3. Article 7(c) Its potential to generate a crisis situation and its potential use in bioterrorism

Since *Varroa* is already present worldwide, the potential to generate a crisis situation is null.

Since *Varroa* is already present worldwide, the potential use of *V. destructor* as agroterrorism agent is not relevant. It cannot be used for bioterrorism. The species is not listed in the bioterrorism lists.

3.1.4. Article 7(d) The feasibility, availability and effectiveness of the following disease prevention and control measures

3.1.4.1. Article 7(d)(i) Diagnostic tools and capacities

Availability

Parameter 1 – Officially/internationally recognised diagnostic tool, OIE certified

Varroosis is an OIE listed disease. The OIE manual describes three methods to diagnose the presence of *Varroa* mites in colonies: examination of honeybee colony debris, honeybee adults and honeybee brood – see Section 3.1.1.8 (OIE, 2008).

Effectiveness

Parameter 2 – Se and Sp of diagnostic test

In Europe, there is only one species of *Varroa* mites hosted in honeybee colonies. The other free-living mites present in colonies are pollen mites, which are not so frequent and morphologically sufficiently different from *Varroa* mites to be easily distinguished. Therefore, the specificity of diagnostic tests is considered high.

The sensitivity of tests has never been assessed and published with the exception of adult bee samples in US (Lee et al., 2010). In this publication, the authors differentiate the needs in terms of precision for beekeepers and researchers to evaluate *Varroa* population at apiary level. Researchers can estimate apiary-level mite density by taking one 300-bee sample unit per colony, but should do so from a variable number of colonies, depending on apiary size. An overview and detailed description of the available diagnostic tools is given in Volume II of the COLOSS BeeBook ('Standard') (Dietemann et al., 2013).

Feasibility

Parameter 3 – Type of sample matrix to be tested (blood, tissue, etc.)

Matrices to be sampled, depending on the techniques applied are adult honeybees, worker brood, drone brood or debris from the bottom of the hive by direct observation. Sampling debris from the bottom of hive can be performed at any time of the year as it is a non-invasive technique (it is not necessary to open the hive). Sampling adult honeybees is quite straightforward but needs the hive to be open which means adequate temperature and climate. Sampling drone and worker brood is the most destructive protocol and is dependent on the season (Dietemann et al., 2013).

3.1.4.2. Article 7(d)(ii) Vaccination

This is not applicable because no vaccination is available against *V. destructor* infection.

3.1.4.3. Article 7(d)(iii) Medical treatments

Availability

Parameter 1 – Types of drugs available on the market

Over the last 20 years, the most noted synthetic acaricides against *V. destructor* are the organophosphate coumaphos, the pyrethroids tau-fluvalinate and flumethrin as well as the formamidine amitraz.

Most of these acaricides are easy to apply, economically convenient, and do not require refined knowledge of the mites' biology. Veterinary treatments require a prescription from veterinarians. Furthermore, as lipophilic substances they are mainly absorbed by the bees' wax, thus not directly jeopardising the honey. However, they are persistent and accumulate after repeated treatments (Rosenkranz et al., 2010). Contamination of beeswax can have negative consequences on bee health and on *Varroa* resistance (Collins et al., 2004; Medici et al., 2015). The European Medicines Agency (EMA) hosts the Coordination Group for Mutual Recognition and Decentralised Procedures – Veterinary (CMDv) that deals with the mutual recognition and decentralised procedure. The mutual recognition within the EU is a procedure through which an authorisation of a medicine in one EU MS is recognised by another MS. The CMDv released a document in 2015 listing all the treatments against *Varroa* allowed in the EU (for instance Checkmite®, Perizin®, Apistan®, Apivar® and Bayvarol®) (EMA and CMDv, 2015).

Organic acids and essential oils, namely formic acid, oxalic acid, lactic acid and thymol, represent the frame of natural compounds used for the control of Varroosis. An enormous number of studies have been conducted regarding the details of application under different climatic and beekeeping conditions, i.e. concentration, time and number of treatments, method of application (powdering, feeding, evaporating, fumigating, trickling or spraying) and others (Rosenkranz et al., 2010).

Parameter 2 – Availability/production capacity (per year)

The production of veterinary medicines is not limited in quantity. However, to overcome resistance that mites have developed to the current active substances used to control varroosis, there is a need for new acaricides to be developed by the industry (O'Brien et al., 2017), also a need to raise awareness for the application of an integrated strategy for *Varroa* control together with a re-thinking of agricultural techniques that may threaten or weaken bee colonies.

Effectiveness

Parameter 3 – Therapeutic effects on the field (effectiveness)

Acaricide treatments are effective in the field although some resistances have been already described (see above). A summary of the different efficacies and detected resistances tested in different types of climate, breeding seasons of colonies is not available as figures are scattered in different publications, thus requiring a meta-analysis of data. 'Rotation' in the use of different acaricides within a 'resistance management plan' is a crucial recommendation; however, this might be of limited effect due to the mainly non-professional structure of the beekeepers' community. Therefore, it is necessary to replace the often chemical-based *Varroa* control strategies with alternative methods (Rosenkranz et al., 2010).

Feasibility

Parameter 4 – Way of administration

There is a large choice of veterinary medicines used in the EU to control *V. destructor* (although they rely on a limited number of active substances, see above). The commercial formulations include the use of strips to be inserted in the colonies, solutions applied by trickling, spraying, fumigating or as pure crystals (e.g. sublimated with heat) without or with sugar, or in saturated absorbent blocks placed over the brood combs. Mutinelli (2016) provides a summary of the information available on veterinary medicines authorised in the EU and Switzerland.

3.1.4.4. Article 7(d)(iv) Biosecurity measures

As it is not possible to prevent entry of *Varroa* in a colony, there are no biosecurity measures specifically related to this disease. One basic measure would be to avoid relocation of frames from one colony to another. Preventing swarming could also decrease *Varroa* spread by vertical transmission.

3.1.4.5. Article 7(d)(v) Restrictions on the movement of animals and products

Due to the route of transmission, restriction of the movement of bee colonies is not effective to prevent the spread of *Varroa*. Restrictions on the movement of bee products are not relevant because *Varroa* would only survive a few hours without living bees. The Commission Implementing Decision 2013/503/EU lays down free areas from varroosis in bees in the Union and establishes additional guarantees for intra-Union trade and imports for the protection of their varroosis-free status. Within EU affected areas, exchanges of colonies, packages of bees or queens are allowed provided they have a sanitary certificate and that the exchange is registered in the European TRACE database.

3.1.4.6. Article 7(d)(vi) Killing of animals

Honeybee colonies should not be killed if *Varroa* mite presence is diagnosed in the colonies, instead the colony should be treated.

3.1.4.7. Article 7(d)(vii) Disposal of carcasses and other relevant animal by-products

This is irrelevant for *V. destructor* for the same reasons as above (killing of animals).

3.1.5. Article 7(e) The impact of disease prevention and control measures

3.1.5.1. Article 7(e)(i) The direct and indirect costs for the affected sectors and the economy as a whole

Parameter 1 – Cost of control (e.g. treatment/vaccine, biosecurity)

The cost depends on the means used to control *Varroa* mites. Using medications is usually less time-consuming. Control with biological treatments is more time-consuming as they imply several consecutive treatments. The costs of the drugs whether they are chemicals or organic acids highly depend on the national market. Control using zootechnical methods (queen encaging) is very time consuming, requires technical skills from the beekeepers and can be at risk for the colony. Besides, the impact on the production of beekeeping products is more severe when biological or zootechnical controls are used.

Therefore, the cost of control also depends on the MSs, since the price of medications fluctuates across countries. For an indication, the cost of chemical treatment is estimated at about EUR 4 to 10 for one colony. The price of one colony is estimated from EUR 80 to 150.

Data on the cost differentiated by the type of control (e.g. chemical, cultural, biological) are not available.

Parameter 2 – Cost of eradication (culling, compensation)

This is irrelevant for *V. destructor* as eradication is not possible.

Parameter 3 – Cost of surveillance and monitoring

Eradication or control of spread being not possible, the surveillance of *Varroa* relies on counting the mites or assessing the disease (varroosis). In 2011, the honeybee EURL sent a questionnaire to the national reference laboratories (NRLs) of the 27 EU MSs as well as Kosovo and Norway. Some parts of the questionnaire were dedicated to the surveillance of honeybee diseases. Varroosis with the observation of clinical symptoms was included in 18 countries (Chauzat et al., 2013). The surveillance or the monitoring plans for varroosis can have different goals: the evaluation of a threshold (beyond a certain number of mites the colony is at risk), the evaluation of the treatments implemented at a country level (do the beekeepers correctly treat their colonies? are the treatments effective?) and the control of the disease (mandatory treatments beyond a threshold). The cost of such programs is linked to services (human resources, equipment and consumables) needed for the collection of the information (involvement of public or private veterinarians or beekeepers), the costs of the biological analysis (involvement of the NRL or counting implemented by the beekeepers themselves), the data storage and analysis (data bases need to be maintained, populated and data analysed) and the animation of the network.

As example, some figures of the cost of surveillance are reported in some MSs. In the Czech Republic, the quantitative laboratory examination of winter debris samples is used. The overall cost is around EUR 54 000 per year that include 55,000–60,000 samples. In Italy, according to the BeeNet project, using the sugar powder method, the costs were evaluated at EUR 50/apiary (10 colonies each). The test was implemented once a year in September to 300 apiaries, leading to EUR 15,000/year. In England and Wales, only an approximate global cost can be reported because different types of surveillance were used, but data are not available for each. Every time a colony inspection is completed, several observations are implemented (not specifically *Varroa* levels). The programme in England and Wales runs at approximately EUR 2.0–2.2 millions per year (£1.8–£2 millions). This encompasses the whole program from laboratory, field, logistics and IT costs.

Parameter 4 – Trade loss (bans, embargoes, sanctions) by animal product

The bans on *V. destructor* at EU level are set by the Commission Implementing Decision 2013/503/EU for regulating intra-Union trade and imports for the protection of varroosis-free areas. Introduction bans of capped brood and adults into free areas are in place.

Parameter 5 – Importance of the disease for the affected sector (% loss or € lost compared to business amount of the sector)

Costs are induced by varroosis (veterinary products, working time for treatment) and losses (colony collapse, reduced honey yields). However, given the different rates of varroosis observed across EU and the high variability in costs related to treatment, labour and colonies, it is nearly impossible to quantify losses in EUR at EU level.

3.1.5.2. Article 7(e)(ii) The societal acceptance of disease prevention and control measures

Destruction of hives because of the presence of *V. destructor* would not be accepted by the population as it is totally irrelevant. Bans, embargoes or sanctions because of *V. destructor* would not be accepted by the population either. The surveillance of *V. destructor* is well accepted in many EU MSs.

3.1.5.3. Article 7(e)(iii) The welfare of affected subpopulations of kept and wild animals

Parameter 1 – Welfare impact of control measures on domestic animals

Measures to reduce clinical signs of varroosis on honey bees can improve some components of welfare of bee colonies (see Section 3.1.2.3). On the other hand, there is evidence that acaricide treatment can potentially interfere with the health of individual honey bees and entire colonies (Boncristiani et al., 2012; Adjlane et al., 2016; Garrido et al., 2016).

Parameter 2 – Wildlife depopulation as control measure

This is irrelevant for *V. destructor* as wildlife is not a reservoir of the disease.

3.1.5.4. Article 7(e)(iv) The environment and biodiversity

Environment

Parameter 1 – Use and potential residuals of biocides or medical drugs in environmental compartments (soil, water, feed, manure)

This is irrelevant for *V. destructor* as the veterinary treatments residues are located in beekeeping matrices (honey, beeswax, propolis) that are not environmental compartments. The correct use of chemical control products will not lead to contamination of the environment. A particular attention should be provided for the disposal of veterinary products. Maximum residue limits have been set out for two acaricides (Amitraz and Coumaphos) (Commission Regulation (EU) No 37/2010[5]). A recent publication studied the risk of chronic exposure of consumers to residues through the consumption of contaminated honey and beeswax. The study concluded that the food consumption of honey and beeswax contaminated with residues of plant protection products or veterinary substances considered separately does not compromise the consumer's health (Wilmart et al., 2016).

Biodiversity

Parameter 2 – Mortality in wild species

This is irrelevant for *V. destructor* as wildlife is not a reservoir of these mites and no data exist on *Varroa* detection in feral colonies across the EU.

[5] Commission Regulation (EU) No 37/2010 of 22 December 2009 on pharmacologically active substances and their classification regarding maximum residue limits in foodstuffs of animal origin. OJ L 15, 20.1.2010, p. 1–72.

3.2. Assessment according to Article 5 criteria

This section presents the results of the expert judgement on the criteria of Article 5 of the AHL about varroosis (Table 2). The expert judgement was based on Individual and Collective Behavioural Aggregation (ICBA) approach described in detail in the opinion on the methodology (EFSA AHAW Panel, 2017). Experts have been provided with information of the disease fact-sheet mapped into Article 5 criteria (see supporting information, Annex A), based on that the experts indicate their Y/N or 'na' judgement on each criterion of Article 5, and the reasoning supporting their judgement.

The minimum number of judges in the judgement was 12. The expert judgement was conducted as described in the methodological opinion (EFSA AHAW Panel, 2017). For details on the interpretation of the questions, see Appendix B of the methodological opinion (EFSA AHAW Panel, 2017).

Table 2: Outcome of the expert judgement on the Article 5 criteria for varroosis

Criteria to be met by the disease: According to AHL, a disease shall be included in the list referred to in point (b) of paragraph 1 of Article 5 if it has been assessed in accordance with Article 7 and meets all of the following criteria		**Final outcome**
A(i)	The disease is transmissible	Y
A(ii)	Animal species are either susceptible to the disease or vectors and reservoirs thereof exist in the Union	Y
A(iii)	The disease causes negative effects on animal health or poses a risk to public health due to its zoonotic character	Y
A(iv)	Diagnostic tools are available for the disease	Y
A(v)	Risk-mitigating measures and, where relevant, surveillance of the disease are effective and proportionate to the risks posed by the disease in the Union	NC
At least one criterion to be met by the disease: In addition to the criteria set out above at points A(i)–A(v), the disease needs to fulfil at least one of the following criteria		
B(i)	The disease causes or could cause significant negative effects in the Union on animal health, or poses or could pose a significant risk to public health due to its zoonotic character	Y
B(ii)	The disease agent has developed resistance to treatments and poses a significant danger to public and/or animal health in the Union	Y
B(iii)	The disease causes or could cause a significant negative economic impact affecting agriculture or aquaculture production in the Union	Y
B(iv)	The disease has the potential to generate a crisis or the disease agent could be used for the purpose of bioterrorism	N
B(v)	The disease has or could have a significant negative impact on the environment, including biodiversity, of the Union	N

Colour code: green = consensus (Yes/No), yellow = non-consensus (NC).

3.2.1. Non-consensus questions

This section displays the assessment related to each criterion of Article 5 where no consensus was achieved in form of tables (Table 3). The proportion of Y, N or na answers are reported, followed by the list of different supporting views for each answer.

Table 3: Outcome of the expert judgement related to criterion 5 A(v)

Question		**Final outcome**	**Response**		
			Y (%)	**N (%)**	**na (%)**
A(v)	Risk-mitigating measures and, where relevant, surveillance of the disease are effective and proportionate to the risks posed by the disease in the Union	NC	67	33	0

NC: non-consensus; number of judges: 12.

Reasoning supporting the judgement

Supporting Yes:

- Multiple risk-mitigating measures such as zootechnical control and chemical treatments are available and generally effective to control *Varroa*, even though not to eliminate it. These have to become an integral part of beekeeping to maintain infestation levels below damage thresholds and to reduce colony losses.

Supporting No:

- Risk-mitigating measures, although widely applied, are not totally effective, even if they are well-applied, their efficacy is variable, and varroosis is still considered one of the most important factors for economic losses in the bee sector. Accuracy for treatments is also needed. Biosecurity measures are not effective.

3.2.2. Outcome of the assessment of varroosis according to criteria of Article 5 (3) of the AHL on its eligibility to be listed

As from the legal text of the AHL, a disease is considered eligible to be listed as laid down in Article 5 if it fulfils all criteria of the first set from A(i) to A(v) and at least one of the second set of criteria from B(i) to B(v). According to the assessment methodology (EFSA AHAW Panel, 2017), a criterion is considered fulfilled when the outcome is 'Yes'. According to the results shown in Table 2, varroosis does not comply with all criteria of the first set because the assessment is inconclusive on compliance with criterion 5 A(v). Therefore, it is inconclusive whether varroosis can be considered eligible to be listed for Union intervention as laid down in Article 5(3) of the AHL.

3.3. Assessment according to Article 9 criteria

This section presents the results of the expert judgement on the criteria of Annex IV referring to categories as in Article 9 of the AHL about varroosis (Tables 4, 5, 6, 7 and 8). The expert judgement was based on ICBA approach described in detail in the opinion on the methodology. Experts have been provided with information of the disease fact-sheet mapped into Article 9 criteria (see supporting information, Annex A), based on that the experts indicate their Y/N or 'na' judgement on each criterion of Article 9, and the reasoning supporting their judgement.

The minimum number of judges in the judgement was 12. The expert judgement was conducted as described in the methodological opinion (EFSA AHAW Panel, 2017). For details on the interpretation of the questions see Appendix B of the methodological opinion (EFSA AHAW Panel, 2017).

Table 4: Outcome of the expert judgement related to the criteria of Section 1 of Annex IV (category A of Article 9) for varroosis (CI: current impact; PI: potential impact)

Criteria to be met by the disease: The disease needs to fulfil all of the following criteria		**Final outcome**
1	The disease is not present in the territory of the Union OR present only in exceptional cases (irregular introductions) OR present only in a very limited part of the territory of the Union	N
2.1	The disease is highly transmissible	NC
2.2	There are possibilities of airborne or waterborne or vector-borne spread	N
2.3	The disease affects multiple species of kept and wild animals OR single species of kept animals of economic importance	Y
2.4	the disease may result in high morbidity and significant mortality rates	Y
At least one criterion to be met by the disease: In addition to the criteria set out above at points 1–2.4, the disease needs to fulfil at least one of the following criteria		
3	The disease has a zoonotic potential with significant consequences on public health, including epidemic or pandemic potential OR possible significant threats to food safety	N
4(CI)	The disease has a significant impact on the economy of the Union, causing substantial costs, mainly related to its direct impact on the health and productivity of animals	Y

4(PI)	The disease has a significant impact on the economy of the Union, causing substantial costs, mainly related to its direct impact on the health and productivity of animals	Y
5(a)(CI)	The disease has a significant impact on society, with in particular an impact on labour markets	N
5(a)(PI)	The disease has a significant impact on society, with in particular an impact on labour markets	NC
5(b)(CI)	The disease has a significant impact on animal welfare, by causing suffering of large numbers of animals	na
5(b)(PI)	The disease has a significant impact on animal welfare, by causing suffering of large numbers of animals	na
5(c)(CI)	The disease has a significant impact on the environment, due to the direct impact of the disease OR due to the measures taken to control it	N
5(c)(PI)	The disease has a significant impact on the environment, due to the direct impact of the disease OR due to the measures taken to control it	N
5(d)(CI)	The disease has a significant impact on a long-term effect on biodiversity or the protection of endangered species or breeds, including the possible disappearance or long-term damage to those species or breeds	N
5(d)(PI)	The disease has a significant impact on a long-term effect on biodiversity or the protection of endangered species or breeds, including the possible disappearance or long-term damage to those species or breeds	N

Colour code: green = consensus (Yes/No), yellow = non-consensus (NC), red = not applicable (na), i.e. insufficient evidence or irrelevant to judge.

Table 5: Outcome of the expert judgement related to the criteria of Section 2 of Annex IV (category B of Article 9) for varroosis (CI: current impact; PI: potential impact)

Criteria to be met by the disease: The disease needs to fulfil all of the following criteria		**Final outcome**
1	The disease is present in the whole OR part of the Union territory with an endemic character AND (at the same time) several Member States or zones of the Union are free of the disease	N
2.1	The disease is moderately to highly transmissible	NC
2.2	There are possibilities of airborne or waterborne or vector-borne spread	N
2.3	The disease affects single or multiple species	Y
2.4	The disease may result in high morbidity with in general low mortality	N
At least one criterion to be met by the disease: In addition to the criteria set out above at points 1–2.4, the disease needs to fulfil at least one of the following criteria		
3	The disease has a zoonotic potential with significant consequences on public health, including epidemic potential OR possible significant threats to food safety	N
4(CI)	The disease has a significant impact on the economy of the Union, causing substantial costs, mainly related to its direct impact on the health and productivity of animals	Y
4(PI)	The disease has a significant impact on the economy of the Union, causing substantial costs, mainly related to its direct impact on the health and productivity of animals	Y
5(a)(CI)	The disease has a significant impact on society, with in particular an impact on labour markets	N
5(a)(PI)	The disease has a significant impact on society, with in particular an impact on labour markets	NC
5(b)(CI)	The disease has a significant impact on animal welfare, by causing suffering of large numbers of animals	na
5(b)(PI)	The disease has a significant impact on animal welfare, by causing suffering of large numbers of animals	na
5(c)(CI)	The disease has a significant impact on the environment, due to the direct impact of the disease OR due to the measures taken to control it	N
5(c)(PI)	The disease has a significant impact on the environment, due to the direct impact of the disease OR due to the measures taken to control it	N

5(d)(CI)	The disease has a significant impact on a long-term effect on biodiversity or the protection of endangered species or breeds, including the possible disappearance or long-term damage to those species or breeds	N
5(d)(PI)	The disease has a significant impact on a long-term effect on biodiversity or the protection of endangered species or breeds, including the possible disappearance or long-term damage to those species or breeds	N

Colour code: green = consensus (Yes/No), yellow = non-consensus (NC), red = not applicable (na), i.e. insufficient evidence or irrelevant to judge.

Table 6: Outcome of the expert judgement related to the criteria of Section 3 of Annex IV (category C of Article 9) for varroosis (CI: current impact; PI: potential impact)

Criteria to be met by the disease: The disease needs to fulfil all of the following criteria		**Final outcome**
1	The disease is present in the whole OR part of the Union territory with an endemic character	Y
2.1	The disease is moderately to highly transmissible	NC
2.2	The disease is transmitted mainly by direct or indirect transmission	Y
2.3	The disease affects single or multiple species	Y
2.4	The disease usually does not result in high morbidity and has negligible or no mortality AND often the most observed effect of the disease is production loss	N
At least one criterion to be met by the disease: In addition to the criteria set out above at points 1–2.4, the disease needs to fulfil at least one of the following criteria		
3	The disease has a zoonotic potential with significant consequences on public health, or possible significant threats to food safety	N
4(CI)	The disease has a significant impact on the economy of parts of the Union, mainly related to its direct impact on certain types of animal production systems	N
4(PI)	The disease has a significant impact on the economy of parts of the Union, mainly related to its direct impact on certain types of animal production systems	N
5(a)(CI)	The disease has a significant impact on society, with in particular an impact on labour markets	N
5(a)(PI)	The disease has a significant impact on society, with in particular an impact on labour markets	NC
5(b)(CI)	The disease has a significant impact on animal welfare, by causing suffering of large numbers of animals	na
5(b)(PI)	The disease has a significant impact on animal welfare, by causing suffering of large numbers of animals	na
5(c)(CI)	The disease has a significant impact on the environment, due to the direct impact of the disease OR due to the measures taken to control it	N
5(c)(PI)	The disease has a significant impact on the environment, due to the direct impact of the disease OR due to the measures taken to control it	N
5(d)(CI)	The disease has a significant impact on a long-term effect on biodiversity or the protection of endangered species or breeds, including the possible disappearance or long-term damage to those species or breeds	N
5(d)(PI)	The disease has a significant impact on a long-term effect on biodiversity or the protection of endangered species or breeds, including the possible disappearance or long-term damage to those species or breeds	N

Colour code: green = consensus (Yes/No), yellow = non-consensus (NC), red = not applicable (na), i.e. insufficient evidence or irrelevant to judge.

Table 7: Outcome of the expert judgement related to the criteria of Section 4 of Annex IV (category D of Article 9) for varroosis

Criteria to be met by the disease: The disease needs to fulfil all of the following criteria		**Final outcome**
D	The risk posed by the disease in question can be effectively and proportionately mitigated by measures concerning movements of animals and products in order to prevent or limit its occurrence and spread	N
The disease fulfils criteria of Sections 1, 2, 3 or 5 of Annex IV of AHL		NC

Colour code: green = consensus (Yes/No), yellow = non-consensus (NC).

Table 8: Outcome of the expert judgement related to the criteria of Section 5 of Annex IV (category E of Article 9) for varroosis

Diseases in category E **need to fulfil criteria of Sections 1, 2 or 3 of Annex IV of AHL** and/or the following:		**Final outcome**
E	Surveillance of the disease is necessary for reasons relating to animal health, animal welfare, human health, the economy, society or the environment (If a disease fulfils the criteria as in Article 5, thus being eligible to be listed, consequently category E would apply.)	NC

Colour code: yellow = non-consensus (NC).

3.3.1. Non-consensus-questions

This section displays the assessment related to each criterion of Annex IV referring to the categories of Article 9 of the AHL where no consensus was achieved in form of tables (Tables 9 and 10). The proportion of Y, N or 'na' answers is reported, followed by the list of different supporting views for each answer.

Table 9: Outcome of the expert judgement related to criterion 2.1 of Article 9

Question		**Final outcome**	**Response**		
			Y (%)	**N (%)**	**na (%)**
2.1 (cat. A)	The disease is highly transmissible	NC	33	59	8
2.1 (cat. B, C)	The disease is moderately to highly transmissible	NC	75	25	0

NC: non-consensus; number of judges: 12.

Reasoning supporting the judgement

Supporting Yes for 2.1 (cat. A):

- In any *Varroa*-free area (naïve colonies) if the mite is introduced (e.g. even by one single drone), the spread between and within the colonies will be highly effective, quick and initially undetected and therefore difficult to demonstrate how quickly the spread occurred to an individual hive.

Supporting na for 2.1 (cat. A):

- There is limited scientific data to support high transmission.

Supporting Yes for 2.1 (cat. B, C):

- There might be high transmissibility in *Varroa*-free areas, but it is not always highly transmissible because the speed of spread depends on the density of populations, mitigating measures of bees and beekeepers as well as other factors.
- The rate of transmission within a colony varies depending on the colony's development of hygienic behaviour against *Varroa*.
- *Varroa* has spread to the entire Union in a few decades, which would confirm at least moderate transmissibility.

Table 10: Outcome of the expert judgement related to criterion 5(a)(PI) of Article 9

Question		**Final outcome**	**Response**		
			Y (%)	**N (%)**	**na (%)**
5a	The disease has a significant impact on society, with in particular an impact on labour markets	NC	92	8	0

NC: non-consensus; number of judges: 12.

Reasoning supporting the judgement

Supporting Yes:

- Beekeepers' activity may be put at risk if losses of colonies are high.
- In the absence of controls, there could be substantial impact as a result of loss of pollination services in agriculture.

Supporting No:

- It is already widespread across Europe and control measures are not always fully effective, therefore the situation is not likely to become worse than the current one which is not of any concern for the labour market.

3.3.2. Outcome of the assessment of criteria in Annex IV for varroosis for the purpose of categorisation as in Article 9 of the AHL

As from the legal text of the AHL, a disease is considered fitting in a certain category (A, B, C, D or E corresponding to point (a) to point (e) of Article 9(1) of the AHL) if it is eligible to be listed for Union intervention as laid down in Article 5(3) and fulfils all criteria of the first set from 1 to 2.4 and at least one of the second set of criteria from 3 to 5(d) as shown in Tables 4–8. According to the assessment methodology (EFSA AHAW Panel, 2017), a criterion is considered fulfilled when the outcome is 'Yes'. With respect to different type of impact where the assessment is divided into current and potential impact, a criterion will be considered fulfilled if at least one of the two outcomes is 'Y' and, in case of no 'Y', the assessment is inconclusive if at least one outcome is 'NC'.

A description of the outcome of the assessment of criteria in Annex IV for varroosis for the purpose of categorisation as in Article 9 of the AHL is presented in Table 11.

Table 11: Outcome of the assessment of criteria in Annex IV for varroosis for the purpose of categorisation as in Article 9 of the AHL

Category	Article 9 criteria										
	1° set of criteria					2° set of criteria					
	1	2.1	2.2	2.3	2.4	3	4	5a	5b	5c	5d
	Geographical distribution	Transmissibility	Routes of transmission	Multiple species	Morbidity and mortality	Zoonotic potential	Impact on economy	Impact on society	Impact on animal welfare	Impact on environment	Impact on biodiversity
A	N	NC	N	Y	Y	N	Y	NC	na	N	N
B	N	NC	N	Y	N	N	Y	NC	na	N	N
C	Y	NC	Y	Y	N	N	N	NC	na	N	N
D	N										
E	NC										

According to the assessment here performed, varroosis complies with the following criteria of the Sections 1–5 of Annex IV of the AHL for the application of the disease prevention and control rules referred to in points (a)–(e) of Article 9(1):

1) To be assigned to category A, a disease needs to comply with all criteria of the first set (1, 2.1–2.4) and according to the assessment varroosis complies with criteria 2.3 and 2.4, but not with criteria 1 and 2.2 and the assessment is inconclusive on compliance with criterion 2.1. To be eligible for category A, a disease needs to comply additionally with one of the criteria of the second set (3, 4, 5a–d) and varroosis complies with criterion 4, but not with criteria 3, 5c and 5d, the assessment is inconclusive on compliance with criterion 5a and not applicable on criterion 5b.
2) To be assigned to category B, a disease needs to comply with all criteria of the first set (1, 2.1–2.4) and according to the assessment varroosis complies with criterion 2.3, but not

with criteria 1, 2.2 and 2.4 and the assessment is inconclusive on compliance with criterion 2.1. To be eligible for category B, a disease needs to comply additionally with one of the criteria of the second set (3, 4, 5a–d) and varroosis complies with criterion 4, but not with criteria 3, 5c and 5d, the assessment is inconclusive on compliance with criterion 5a and not applicable on criterion 5b.

3) To be assigned to category C, a disease needs to comply with all criteria of the first set (1, 2.1–2.4) and according to the assessment varroosis complies with criteria 1, 2.2 and 2.3, but not with criterion 2.4 and the assessment is inconclusive on compliance with criterion 2.1. To be eligible for category C, a disease needs to comply additionally with one of the criteria of the second set (3, 4, 5a–d) and varroosis does not comply with criteria 3, 4, 5c and 5d, the assessment is inconclusive on compliance with criterion 5a and not applicable on criterion 5b.
4) To be assigned to category D, a disease needs to comply with criteria of Sections 1, 2, 3 or 5 of Annex IV of the AHL, whose assessment performed is inconclusive for varroosis, and with the specific criterion D of Section 4, with which varroosis does not comply.
5) To be assigned to category E, a disease needs to comply with criteria of Sections 1, 2 or 3 of Annex IV of the AHL and/or the surveillance of the disease is necessary for reasons relating to animal health, animal welfare, human health, the economy, society or the environment. The latter is applicable if a disease fulfils the criteria as in Article 5 and the assessment here performed for varroosis is inconclusive on compliance with the criteria as in Article 5.

3.4. Assessment of Article 8

This section presents the results of the assessment on the criteria of Article 8(3) of the AHL about varroosis. The Article 8(3) criteria are about animal species to be listed, as it reads below:

'3. Animal species or groups of animal species shall be added to this list if they are affected or if they pose a risk for the spread of a specific listed disease because:

a) they are susceptible for a specific listed disease or scientific evidence indicates that such susceptibility is likely; or
b) they are vector species or reservoirs for that disease, or scientific evidence indicates that such role is likely'.

For this reason, the assessment on Article 8 criteria is based on the evidence as extrapolated from the relevant criteria of Article 7, i.e. the ones related to susceptible and reservoir species or routes of transmission, which cover also possible role of biological or mechanical vectors.[6] According to the mapping, as presented in Table 5, Section 3.2 of the scientific opinion on the ad hoc methodology (EFSA AHAW Panel, 2017), the main animal species to be listed for varroosis according to the criteria of Article 8(3) of the AHL are as displayed in Table 12.

Table 12: Main animal species to be listed for varroosis according to criteria of Article 8 (source: data reported in Section 3.1.1.1)

	Class	Order	Family	Genus/Species
Susceptible	Insecta	Hymenoptera	Apidae	Western honey bee (*Apis mellifera*), Eastern honey bee (*Apis cerana*)
Reservoir	Insecta	Hymenoptera	Apidae	Western honey bee (*Apis mellifera*), Eastern honey bee (*Apis cerana*), Philippine honey bee (*Apis nigrocincta*)
Vectors	none			

4. Conclusions

TOR 1: *for each of those diseases an assessment, following the criteria laid down in Article 7 of the AHL, on its eligibility of being listed for Union intervention as laid down in Article 5(3) of the AHL;*

[6] A vector is a living organism that transmits an infectious agent from an infected animal to a human or another animal. Vectors are frequently arthropods. Biological vectors may carry pathogens that can multiply within their bodies and be delivered to new hosts, usually by biting. In mechanical vectors, the pathogens do not multiply within the vector, which usually remains infected for shorter time than in biological vectors.

- According to the assessment here performed, it is inconclusive whether varroosis can be considered eligible to be listed for Union intervention as laid down in Article 5(3) of the AHL. Eligibility of listing varroosis is dependent on a decision on criterion 5 A(v).

TOR 2a: *for each of the diseases which was found eligible to be listed for Union intervention, an assessment of its compliance with each of the criteria in Annex IV to the AHL for the purpose of categorisation of diseases in accordance with Article 9 of the AHL;*

- According to the assessment here performed, since it is inconclusive whether varroosis can be considered eligible to be listed for Union intervention as laid down in Article 5(3) of the AHL, then also the assessment of its compliance with each of the criteria in Annex IV to the AHL for the purpose of categorisation of diseases in accordance with Article 9 of the AHL is inconclusive.

TOR 2b: *for each of the diseases which was found eligible to be listed for Union intervention, a list of animal species that should be considered candidates for listing in accordance with Article 8 of the AHL.*

- According to the assessment here performed, since it is inconclusive whether varroosis can be considered eligible to be listed for Union intervention as laid down in Article 5(3) of the AHL, then it is also inconclusive which animal species can be considered to be listed for varroosis according to Article 8(3) of the AHL.

References

Adjlane N, Tarek E-O and Haddad N, 2016. Evaluation of oxalic acid treatments against the mite *Varroa destructor* and secondary effects on honey bees *Apis mellifera*. Journal of Arthropod-Borne Diseases, 10, 501–509.

Anderson DL and Trueman JW, 2000. *Varroa jacobsoni* (Acari: Varroidae) is more than one species. Experimental and Applied Acarology, 24, 165–189.

Boecking O and Genersch E, 2008. Varroosis - the ongoing crisis in bee keeping. Journal für Verbraucherschutz und Lebensmittelsicherheit, 3, 221–228.

Boncristiani H, Underwood R, Schwarz R, Evans JD, Pettis J and vanEngelsdorp D, 2012. Direct effect of acaricides on pathogen loads and gene expression levels in honey bees Apis mellifera. Journal of Insect Physiology, 58, 613–620.

Breeze TD, Vaissière BE, Bommarco R, Petanidou T, Seraphides N, Kozák L, Scheper J, Biesmeijer JC, Kleijn D, Gyldenkærne S, Moretti M, Holzschuh A, Steffan-Dewenter I, Stout JC, Pärtel M, Zobel M and Potts SG, 2014. Agricultural policies exacerbate honeybee pollination service supply-demand mismatches across Europe. PLoS ONE, 9, e82996.

Chauzat MP, Cauquil L, Roy L, Franco S, Hendrikx P and Ribière-Chabert M, 2013. Demographics of the European beekeeping industry. PLoS ONE, 8, 1–12.

Collins AM, Pettis JS, Wilbanks R and Feldlaufer MF, 2004. Performance of honey bee (*Apis mellifera*) queens reared in beeswax cells impregnated with coumaphos. Journal of Apicultural Research, 43, 128–134.

De Jong D, De Andrea Roma D and Gonçalves LS, 1982. A comparative analysis of shaking solutions for the detection of *Varroa jacobsoni* on adult honeybees. Adipologie, 13, 297–306.

Dietemann V, Nazzi F, Martin SJ, Anderson DL, Locke B, Delaplane KS, Wauquiez Q, Tannahill C, Frey E, Ziegelmann B, Rosenkranz P and Ellis JD, 2013. Standard methods for varroa research. Journal of Apicultural Research, 52, 1–54.

Duay P, De Jong D and Engels W, 2002. Decreased flight performance and sperm production in drones of the honey bee (*Apis mellifera*) slightly infested by *Varroa destructor* mites during pupal development. Genetics and Molecular Research, 1, 227–232.

Duay P, De Jong D and Engels W, 2003. Weight loss in drone pupae (*Apis mellifera*) multiply infested by *Varroa destructor* mites. Adipologie, 34, 61–65.

EFSA AHAW Panel (EFSA Panel on Animal Health and Welfare), 2016. Scientific opinion on assessing the health status of managed honeybee colonies (HEALTHY-B): a toolbox to facilitate harmonised data collection. EFSA Journal 2016;14(10):4578, 241 pp. https://doi.org/10.2903/j.efsa.2016.4578

EFSA AHAW Panel (EFSA Panel on Animal Health and Welfare), More S, Bøtner A, Butterworth A, Calistri P, Depner K, Edwards S, Garin-Bastuji B, Good M, Gortázar Schmidt C, Michel V, Miranda MA, Nielsen SS, Raj M, Sihvonen L, Spoolder H, Stegeman JA, Thulke H-H, Velarde A, Willeberg P, Winckler C, Baldinelli F, Broglia A, Candiani D, Gervelmeyer A, Zancanaro G, Kohnle L, Morgado J and Bicout D, 2017. Scientific opinion on an ad hoc method for the assessment on listing and categorisation of animal diseases within the framework of the Animal Health Law. EFSA Journal 2017;15(5):4783, 42 pp. https://doi.org/10.2903/j.efsa.2017.4783

EMA and CMDv (European Medicines Agency and Coordination Group for Mutual Recognition and Decentralised Procedures - Veterinary), 2015. Bee products: situation in Europe. 43 pp. Available online: http://www.apiservices.biz/documents/articles-en/bee_treatment_products_situation_europe.pdf

European Commission, 2008. Insect pollination worth EUR 153 billion a year. Available online: http://cordis.europa.eu/news/rcn/29867_en.html [Accessed: 7 September 2017]

Frey E and Rosenkranz P, 2014. Autumn invasion rates of *Varroa destructor* (Mesostigmata: Varroidae) into honey bee (Hymenoptera: Apidae) colonies and the resulting increase in mite populations. Journal of Economic Entomology, 107, 508–515.

Frey E, Schnell H and Rosenkranz P, 2011. Invasion of *Varroa destructor* mites into mite-free honey bee colonies under the controlled conditions of a military training area. Journal of Apicultural Research, 50, 138–144.

Fries I, Imdorf A and Rosenkranz P, 2006. Survival of mite infested (*Varroa destructor*) honey bee (*Apis mellifera*) colonies in a Nordic climate. Apidologie, 37, 564–570.

Gallai N, Salles JM, Settele J and Vaissière BE, 2009. Economic valuation of the vulnerability of word agriculture confronted with pollinator decline. Ecological Economics, 68, 810–821.

Garibaldi LA, Steffan-Dewenter I, Winfree R, Aizen MA, Bommarco R, Cunningham SA, Kremen C, Carvalheiro LG, Harder LD, Afik O, Bartomeus I, Benjamin F, Boreux V, Cariveau D, Chacoff NP, Dudenhöffer JH, Freitas BM, Ghazoul J, Greenleaf S, Hipólito J, Holzschuh A, Howlett B, Isaacs R, Javorek SK, Kennedy CM, Krewenka KM, Krishnan S, Mandelik Y, Mayfield MM, Motzke I, Munyuli T, Nault BA, Otieno M, Petersen J, Pisanty G, Potts SG, Rader R, Ricketts TH, Rundlöf M, Seymour CL, Schüepp C, Szentgyörgyi H, Taki H, Tscharntke T, Vergara CH, Viana BF, Wanger TC, Westphal C, Williams N and Klein AM, 2013. Wild pollinators enhance fruit set of crops regardless of honey bee abundance. Science, 339, 1608.

Garrido PM, Porrini MP, Antunez K, Branchiccela B, Martinez-Noel GM, Zunino P, Salerno G, Eguaras MJ and Ieno E, 2016. Sublethal effects of acaricides and Nosema ceranae infection on immune related gene expression in honeybees. Veterinary Research, 47, 51.

Genersch E, Von der Ohe W, Kaatz HH, Schroeder A, Otten C, Büchler R, Berg S, Ritter W and Mühlen W, 2010. The German bee monitoring project: a long term study to understand periodically high winter losses of honey bee colonies. Apidologie, 41, 332–352.

Giacobino A, Bulacio Cagnolo N, Merke J, Orellano E, Bertozzi E, Masciangelo G, Pietronave H, Salto C and Signorini M, 2014. Risk factors associated with the presence of *Varroa destructor* in honey bee colonies from east-central Argentina. Preventive Veterinary Medicine, 115, 280–287.

Giacobino A, Molineri AI, Pacini A, Fondevila N and Pietronave H, 2016. Varroa destructor and viruses association in honey bee colonies under different climatic conditions. Environmental Microbiology Reports, 8, 407–412.

Gisder S and Genersch E, 2017. Viruses of commercialized insect pollinators. Journal of Invertebrate Pathology, 147, 51–59.

González-Cabrera J, Davies TG, Field LM, Kennedy PJJ and Williamson MS, 2013. An amino acid substitution (L925V) associated with resistance to pyrethroids in *Varroa destructor*. PLoS ONE, 8, e82941.

Jacques A, Laurent M, Ribière-Chabert M, Saussac M, Bougeard S, Hendrikx P and Chauzat M-P, 2016. Statistical analysis on the EPILOBEE dataset: explanatory variables related to honeybee colony mortality in EU during a 2 year survey. EFSA Supporting Publication 2016:EN-883, 228 pp.

Jacques A and Laurent M, Epilobee Consortium, Ribière-Chabert M, Saussac M, Bougeard S, Budge GE, Hendrikx P and Chauzat MP, 2017. A pan-European epidemiological study reveals honey bee colony survival depends on beekeeper education and disease control. PLoS One, 12, e0172591.

Kamler M, Nesvorna M, Stara J, Erban T and Hubert J, 2016. Comparison of tau-fluvalinate, acrinathrin, and amitraz effects on susceptible and resistant populations of *Varroa destructor* in a vial test. Experimental and Applied Acarology, 69, 1–9.

Kang Y, Blanco K, Davis T, Wang Y and DeGrandi-Hoffman G, 2015. Disease dynamics of honeybees with *Varroa destructor* as parasite and virus vector. Mathematical Biosciences, 275, 71–92.

Kralj J and Fuchs S, 2006. Parasitic *Varroa destructor* mites influence flight duration and homing ability of infested *Apis mellifera* foragers. Adipologie, 37, 577–587.

Kralj J, Brockmann A, Fuchs S and Tautz J, 2007. The parasitic mite *Varroa destructor* affects non-associative learning in honey bee foragers, *Apis mellifera* L. Journal of Comparative Physiology. A, Neuroethology, Sensory, Neural, and Behavioral Physiology, 193, 363–370.

Kretzchmar A, Maisonnasse A, Dussaubat C, Cousin M and Vidau C, 2016. Performances des colonies vues par les observatoires de ruchers. Innovations Agronomiques, 39–50.

Laurent M, Hendrikx P, Ribière-Chabert M and Chauzat M-P,2016. A pan-European epidemiological study on honeybee colony losses 2012-2014. Available online: https://ec.europa.eu/food/sites/food/files/animals/docs/la_bees_epilobee-report_2012-2014.pdf

Lee KV, Moon RD, Burkness EC, Hutchison WD and Spivak M, 2010. Practical sampling plans for *Varroa destructor* (Acari: Varroidae) in *Apis mellifera* (Hymenoptera: Apidae) colonies and apiaries. Journal of Economic Entomology, 103, 1039–1050.

Martin SJ, Highfield AC, Brettell L, Villalobos EM, Budge GE, Powell M, Nikaido S and Schroeder DC, 2012. Global honey bee viral landscape altered by a parasitic mite. Science, 336, 1304–1306.

McMenamin AJ and Genersch E, 2015. Honey bee colony losses and associated viruses. Current Opinion in Insect Science, 8, 121–129.

Medici S, Maggi M, Sarlo EG, Ruffinengo S, Marioli JM and Eguaras M, 2015. The presence of synthetic acaricides in beeswax and its influence on the development of resistance in *Varroa destructor*. Journal of Apicultural Research, 54, 267–274.

Meixner M, Kryger P and Costa C, 2015. Effects of genotype, environment and their interactions on honey bee health in Europe. Current Opinion in Insect Science, 10, 8.

Milani N, 1995. The resistance of *Varroa jacobsoni* Oud to pyrethroids: a laboratory assay. Apidologie, 26, 415–429.

Milani N, 1999. The resistance of *Varroa jacobsoni* Oud. to acaricides. Apidologie, 30, 229–234.

Mondet F, Alaux C, Severac D, Rohmer M, Mercer AR and Le Conte Y, 2015. Antennae hold a key to Varroa-sensitive hygiene behaviour in honey bees. Scientific Reports, 5, 10454.

Mutinelli F, 2016. Veterinary medicinal products to control *Varroa destructor* in honey bee colonies (*Apis mellifera*) and related EU legislation – an update. Journal of Apicultural Research, 55, 78–88.

Nazzi F and Le Conte Y, 2016. Ecology of *Varroa destructor*, the major ectoparasite of the Western honey bee, *Apis mellifera*. Annual Review of Entomology, 61, 417–432.

O'Brien D, Scudamore J, Charlier J and Delavergne M, 2017. DISCONTOOLS: a database to identify research gaps on vaccines, pharmaceuticals and diagnostics for the control of infectious diseases of animals. BMC Veterinary Research, 13, 1.

OIE (World Organization for Animal Health), 2008. Varroosis of honey bees (infestation of honey bees with *Varroa* spp.). In: Manual of Diagnostic Tests and Vaccines for Terrestrial Animals 2017. 6 pp. Available online: http://www.oie.int/fileadmin/Home/eng/Health_standards/tahm/2.02.07_VARROOSIS.pdf

Potts SG, Biesmeijer JC, Kremen C, Neumann P, Schweiger O and Kunin WE, 2010. Global pollinator declines: trends, impacts and drivers. Trends in Ecology & Evolution, 25, 345–353.

Roberts JM, Anderson DL and Tay WT, 2015. Multiple host shifts by the emerging honeybee parasite, *Varroa jacobsoni*. Molecular Ecology, 24, 2379–2391.

Rosenkranz P, Aumeier P and Ziegelmann B, 2010. Biology and control of *Varroa destructor*. Journal of Invertebrate Pathology, 103, 96–119.

Ryba S, Kindlmann P, Titera D, Haklova M and Stopka P, 2012. A new low-cost procedure for detecting nucleic acids in low-incidence samples: a case study of detecting spores of *Paenibacillus* larvae from bee debris. Journal of Economic Entomology, 105, 1487–1491.

Traynor K, Rennich K, Forsgren E, Rose R, Pettis J, Kunkel G, Madella S, Evans J, Lopez D and Vanengelsdorp D, 2016. Multiyear survey targeting disease incidence in US honey bees. Apidologie, 47, 325–347.

Wilfert L, Long G, Leggett HC, Schmid-Hempel P, Butlin R, Martin SJM and Boots M, 2016. Deformed wing virus is a recent global epidemic in honeybees driven by *Varroa* mites. Science, 351, 594–597.

Wilmart O, Legreve A, Scippo ML, Reybroeck W, Urbain B, de Graaf DC, Steurbaut W, Delahaut P, Gustin P, Nguyen BK and Saegerman C, 2016. Residues in beeswax: a health risk for the consumer of honey and beeswax? Journal of Agricultural and Food Chemistry, 64, 8425–8434.

Abbreviations

AHAW	EFSA Panel on Animal Health and Welfare
AHL	Animal Health Law
CMDv	Coordination Group for Mutual Recognition and Decentralised Procedures – Veterinary
EMA	European Medicines Agency
MS	Member State
NRL	national reference laboratory
Se	diagnostic sensitivity
Sp	diagnostic specificity
ToR	Terms of Reference

Annex A – Mapped fact-sheet used in the individual judgement on infestation with Varroa spp. (Varroosis)

Annex A can be found in the online version of this output ('Supporting information' section): https://doi.org/10.2903/j.efsa.2017.4997